Thicker than Water

Alisa McQueen MD, FAAP, FACEP
Associate Professor of Pediatrics
The University of Chicago
I have no relevant financial relationships to disclose.
Who is bleeding?

How much and what kind of volume?

Can we medically slow down bleeding?
FAST examination

How much and what kind of volume?

Can we medically slow down bleeding?
FAST examination
Damage Control Resuscitation
Can we medically slow down bleeding?
FAST examination

Damage Control Resuscitation

Transexamic Acid (TXA)
FAST examination

How much and what kind of volume?

Can we medically slow down bleeding?
Is there blood in the abdomen?

- **Unstable**
  - DPL
  - Invasive

- **Stable**
  - CT scan
  - Radiation
FAST: Focused Assessment with Sonography in Trauma

Adults: standard of care

Kids?
FAST: Focused Assessment with Sonography in Trauma

Adults: standard of care

Kids: 10-15%
Why don’t we do more pediatric FAST exams?
FAST in Pediatric Trauma

All children < 16 with blunt abdominal trauma

FAST/CT/procedures at the discretion of treatment team

FAST compared with no FAST

FAST in Pediatric Trauma

2188 patients

37.9% FAST
(more likely with MVC, less likely with falls or assault)

FAST in Pediatric Trauma Trial

Stable children with blunt torso trauma randomized standard treatment vs FAST

Suspicion for intra abdominal injury before/after FAST

CT at treating team discretion


975 children

465 No FAST
52% CT

460 FAST
54% CT

No difference in CT rates
No difference in missed injuries
No difference in length of stay
FAST in Pediatric Trauma

Sub-analysis of children with blunt abdominal trauma

20 PECARN EDs

FAST in Pediatric Trauma

How suspicious are you for intra-abdominal injury?

- Frequency of FAST
- Frequency of CT
- Missed intra abdominal injury


<table>
<thead>
<tr>
<th></th>
<th>Very low (&lt;1%)</th>
<th>Low (1-5%)</th>
<th>Moderate (6-10%)</th>
<th>High (11-50%)</th>
<th>Very high (&gt;50%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate (%)</td>
<td>11 %</td>
<td>13 %</td>
<td>20 %</td>
<td>23 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Risk</td>
<td>1.01</td>
<td>0.84</td>
<td>0.86</td>
<td>0.98</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Rate of FAST increased as the suspicion for intra-abdominal injury increased.
RR of CT decreased significantly for low-moderate suspicion injuries when FAST performed.


When excluded site #1, effect of FAST on CT decreased

Figure 1. Percentage of patients with FAST examinations.

Had to exclude because not enough FAST performed
Should we abandon FAST in kids?
Should we abandon FAST in kids?

Unstable kids were not included

CT obtained at discretion of the providers
Maybe we need to do it more

**Figure 1.** Percentage of patients with FAST examinations.

FAST examination

Damage Control Resuscitation

Can we medically slow down bleeding?
Damage Control Resuscitation and Permissive Hypotension
“The Lethal Triad”

Hypothermia
Acidosis
Coagulopathia
Damage Control Resuscitation

Permissive Hypotension
Early blood products over saline
Retrospective study of adults with penetrating trauma and hypotension managed with damage control surgery and damage control resuscitation

Standard fluid (150+ crystalloid)  Restricted fluid (<150 ml crystalloid)


<table>
<thead>
<tr>
<th>Fluid Type</th>
<th>Mortality in OR</th>
<th>Mortality in ICU</th>
<th>Overall Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard fluid (avg 2757ml)</td>
<td>32%</td>
<td>5%</td>
<td>37%</td>
</tr>
<tr>
<td>Restricted fluid (avg 129ml)</td>
<td>9%</td>
<td>12%</td>
<td>21%</td>
</tr>
</tbody>
</table>
Hydrostatic pressure may disrupt clots

Dilution of coagulation factors worsens bleeding

Inflammatory cascade contributes to organ failure
Blood volume varies by age.

Infants: 90 – 100 cc/kg
Young children: 70 – 80 cc/kg
Adolescents: 60– 65 cc/kg
Children can lose up to 45% of their blood volume before becoming hypotensive.
Children with traumatic brain injury may be hypotensive.
Limit isotonic fluids and give blood early.

We don’t know what the target blood pressure should be.

We don’t know what the goals in pediatrics should be.
FAST examination
Damage Control Resuscitation
Transexamic Acid (TXA)
vascular injury during surgery activates coagulation

Fibrinolysis and clot breakdown

TXA

Decreases need for transfusion by 1/3
vascular injury during surgery activates coagulation and clot breakdown

Could it work for trauma?
Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial

CRASH-2 trial collaborators*
CRASH-2

sick trauma patients

TXA

Placebo

Primary outcome: death within 4 weeks in hospital

SBP < 90
HR > 110
Risk for significant bleeding
CRASH-2

20,211 trauma patients

TXA 10,096

Placebo 10,115

14.5% mortality from all causes

16% mortality from all causes

274 hospitals
40 countries

SBP < 90
HR > 110
Risk for significant bleeding

16% mortality from all causes
CRASH-2

20,211 trauma patients

SBP < 90
HR > 110
Risk for significant bleeding

274 hospitals
40 countries

TXA 10,096
4.9% mortality from bleeding

Placebo 10,115
5.7% mortality from bleeding

10,096
10,115
CRASH-2 sub-analysis

1. Time from injury (<1, 1-3, >3h)
2. Severity (SBP <75, 76-89, >89)
3. GCS (3-8, 9-12, 13-15)
4. Type of injury (penetrating/ blunt)
CRASH-2 sub-analysis

1. Time from injury (<1, 1-3, >3h)
2. Severity (SBP <75, 76-89, >89)
3. GCS (3-8, 9-12, 13-15)
4. Type of injury (penetrating/blunt)

The sooner TXA given, the stronger the benefit.

If given after 3 hours, increased risk of thrombotic events.
What do we know about TXA in kids?
What do we know about TXA in kids?

Coagulation cascade is the same by about age 1 year

Safe use in elective surgery (cardiac, scoliosis, craniofacial)
TXA use in U.S. Children’s Hospitals

36 hospitals 2009-2013
TXA use in children < 18 years

64% cardiothoracic surgery
18% scoliosis
3.6% craniofacial
14% other
0.3% trauma

Pediatric TXA in combat setting

Retrospective review of TXA use in children < 18 with trauma in Afghanistan

766 children
Mean age 11
88% male
73% penetrating injury

Eckert MJ et al. TXA administration to pediatric trauma patients in a combat setting (PED-TRAX). J Trauma Acute Care Surg 2014;77:852-858.
Pediatric TXA in combat setting

Retrospective review of TXA use in children < 18 with trauma in Afghanistan

9% received TXA
Tended to be sicker
When controlled for severity, decreased mortality (OR 0.3, p=0.03)

Eckert MJ et al. TXA administration to pediatric trauma patients in a combat setting (PED-TRAX). J Trauma Acute Care Surg 2014;77:852-858.
Key points

- Tranexamic acid reduces mortality in adult trauma
- Early administration is vital for efficacy
- Due to the lack of published data on the use of tranexamic acid in paediatric patients who have undergone major trauma there is no evidence for a specific dose in this situation
- The RCPCH and NPPG Medicines Committee recommend a pragmatic dosage schedule - 15mg/kg tranexamic acid loading dose (max 1g) over 10 minutes followed by 2mg/kg per hour
Thicker than Water
FAST hasn’t been very helpful so far in pediatric trauma.

But we just might need to learn to do it better in kids.
Permissive hypotension in pediatric trauma is probably a bad idea. But giving blood early is probably a good idea.
TXA is likely to help and unlikely to harm when given early to the severely injured pediatric trauma patient.